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ABSTRACT

Recognizing the poor performance of transfer students in the first engineering technology course in the engineering curriculum, (EGET3171), the Engineering Department of the University of North Carolina (Charlotte) developed a Technology Math Placement Test (CAL-T) to assess and place students transferring from community colleges to the university. Two validity studies were conducted to investigate the test's utility as a placement tool. The first study was conducted on 63 students when CAL-T was optional and used only to advise students whether to take EGET3171. The second study was conducted to re-validate CAL-T after a minimum CAL-T score was established to place students, and involved 50 transfer students who had completed EGET3171. Results for both studies indicated that CAL-T was a valid predictor of success in EGET3171. It is concluded that the test can be useful for placing transfer students and can facilitate the smooth transition of students transferring from community colleges to the university while enabling the two types of institutions to follow their respective missions and simultaneously interface. Seven references and two tables. (LPT)

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Interfacing the Efforts of Community Colleges and a University: Placing Engineering Technology Students

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Running Head: Placing Engineering Students

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Abstract

This paper describes the development and validation of a test used to link two types of institutions: community colleges and a university. Advantages are discussed.

Interfacing the Efforts of Community Colleges and a University: Placing Engineering Technology Students

The "production" of engineers is viewed by many scientists as a current problem which must be addressed by our society (A New Agenda for Science, 1987). An equally important and related concern is the status of math education in the United States (National Research Council, 1989). Educational institutions must work together to contribute to the solution of these problems. This paper describes how two types of educational institutions can work together to educate engineering technologists as well as benefit each other. This paper also describes the development and validation of the test used to link the two types of institutions.

Despite the relatively recent wave of public criticism of educational institutions' use of tests (Cannell, 1988; Denton, 1988; Fremer, Diamond, & Camara, 1989; Resnick & Resnick, 1982), most psychometricians continue to acknowledge the value of valid tests (Standards for Educational and Psychological Testing, 1985). One use of tests is the placement of students into faster or slower curriculum tracks. The Engineering Technology Department at the University of North Carolina at Charlotte (UNCC) realized a need to develop a math competency test for placing students transferring from community colleges to the university.

The Engineering Technology Department at UNCC has developed a symbiotic relationship with the community colleges in the surrounding region. The community colleges provide the first 2 years of education for students, and the students transfer to UNCC to complete their coursework for the Bachelors Degree in Engineering Technology. Any student with an Associate's Degree in Applied Science in Engineering Technology from a community college or technical institute in the consortium is accepted to the Engineering Technology Department at UNCC. The benefits realized by the Engineering Technology Department include not having to develop and teach the lower level courses. Consequently, the department's faculty can devote their time to the higher level courses and research. The benefits realized by the colleges include the guaranteed admission of their graduates to an upper division program.

Most of the students in the program have received their Associate's Degrees from colleges in North and South Carolina and Virginia. However, increasingly more entering students have earned their Associate's Degrees from other Eastern states. The variety of community colleges participating in the consortium has resulted in unwanted variability across the incoming students in terms of their math ability and preparedness for advanced math courses. Typically, the students have not taken any standard

college entrance test, e. g., the Scholastic Aptitude Test. Consequently, there was no common scale which could be used to place the students in the required math courses.

During the late 1960s and the 1970s, approximately 75 percent of the transfer students took their first engineering technology analysis course (EGET3171) during their first semester at UNCC. This course primarily revolves around solving word problems using calculus and assumes that students can differentiate and integrate polynomials and trigonometric functions. The foundation for EGET3171 is supposedly established in the last engineering technology math course offered at the community colleges, which is usually the fourth math course (MATH4). However, some students admitted to the Engineering Technology Program either have performed poorly in MATH4, have earned their Associate's Degree without completing MATH4, or have been away from calculus for a number of years. The students' personnel records between 1967 and 1981 indicated that many of the students were failing EGET3171. Moreover, many students who failed EGET3171 expressed frustration with having wasted a semester. It became clear in the late 1970s that a math placement quiz was necessary.

The Technology Math Placement Quiz (CAL-T) was developed in 1981 to assess the incoming students' knowledge of differential and integral calculus. Relatively minor changes were made in the

quiz in 1982 to improve its internal consistency, e. g., five items were replaced. The quiz was originally used to advise students regarding their readiness for EGET3171. However, as data on the test accumulated, it appeared that students answering less than 20 percent of the test correctly typically earned a D or F in EGET3171. The average score on the quiz has usually been between 24 to 26 percent. In Fall 1984, the faculty of the Engineering Technology Department decided to set a 20 percent cutoff, requiring all students scoring below 20 percent on the quiz to take a remedial math course (MATH1120).

The purpose of this study was to determine the validity of the CAL-T for predicting success in EGET3171. If a placement test could not be developed, alternative procedures to remedy the high failure rate in EGET3171 would have had to be sought. However, the university's alternatives were limited by two concerns. The university's Engineering Technology Department has no official control over the community colleges' curricula. In addition, the department wishes to maintain a non-competitive relationship with the community colleges. Consequently, the department could not require the community colleges to require MATH4, and the department believed developing and requiring its own math course could jeopardize its relationship with the colleges. The development of a placement quiz seemed to be the best solution.

Two validity studies were conducted on the quiz to investigate its utility as a placement tool. The first study was conducted on a sample of students who took the CAL-T when it was optional and was used solely as an advising tool. The second study was conducted after a minimum CAL-T score was established to place students.

Study 1

The first validity study was conducted when the CAL-T was optional and was used only to advise students whether to take EGET3171 or a remedial math course MATH1120.

Method

Subjects

The sample (n = 63) consisted of five female and 58 male students transferring from community colleges to UNCC for the following school semesters: Summer 1983, Fall 1983, and Spring 1984. Twenty-one students had not completed MATH4 and 42 had completed the course.

The Technology Math Placement Quiz (CAL-T)

The CAL-T was constructed by three faculty members in the Engineering Technology Department who had taught EGET3171. These three subject matter experts constructed the test as an achievement test to assess the students' mastery of the material supposedly covered in MATH4. They used an introductory calculus textbook as a guide for the topics to include on the quiz. CAL-T

consists of 45 multiple-choice items, with a combination of calculus, differentiation, and integration problems. Some of the items include material at a level below calculus, reviewing the functions used in technical word problems, such as exponential, trigonometric, and logarithmic functions. The quiz is administered with a 90-minute time limit, with most students completing it within the alloted time. The quiz score is computed using a correction for guessing, with the following formula:

$$\text{Quiz Score} = [(N_c - N_i/3)/45] \times 100, \text{ where}$$

N_c = number of items correct

N_i = number of items incorrect.

Procedure

The transfer students completed the CAL-T at the beginning of their first semester at UNCC. All students in each semester were tested together in a large classroom.

The CAL-T was used only to advise students whether or not to take EGET3171, the first required course in the engineering technology curriculum. With no required minimum CAL-T score for entrance into EGET3171, some students who scored poorly on the test took the course.

The various instructors for EGET3171 assigned letter grades (i.e., A, B, C, D, F) at the end of the semesters.

Results

CAL-T correlated significantly ($r = .54$, $p < .01$) with EGET3171 grades, indicating that CAL-T was a valid predictor of success in EGET3171. In addition, completion of MATH4 correlated significantly ($r = .54$, $p < .01$) with EGET3171 grades, and CAL-T and MATH4 correlated significantly ($r = .33$, $p < .01$) with each other.

Stepwise multiple regression analysis was performed, with the CAL-T score and completion of MATH4 as the predictors. The letter grade earned in EGET3171 was the criterion, with A = 4, B = 3, C = 2, D = 1, F = 0. Completion of MATH4 was dummy coded, with 0 = "Did not complete MATH4" and 1 = "Did complete MATH4." The multiple correlation ($R = .66$, $R^2 = .44$) was statistically significant ($F(2, 60) = 23.505$, $p < .001$), and both CAL-T and MATH4 contributed significantly to the prediction of EGET3171 grades. Table 1 contains the descriptive statistics for the variables and Table 2 contains the results from the regression analysis.

Insert Tables 1 and 2 about here

Study 2

Study 2 was conducted to revalidate CAL-T after two changes were made in the implementation of the quiz. Two prerequisites for EGET3171 were instituted at the beginning of Fall Semester 1984: a minimum score of 20 percent on the CAL-T and a D or better in MATH4 or MATH1120, the university's remedial math course. The 20 percent cutoff was rationally set because most students failing EGET3171 had scored below 20 percent on the CAL-T.

Method

Subjects

The total sample (n = 124) consisted of transfer students for the 1986-1987 academic year. Fifty-seven of the students scored 20 percent or better on the CAL-T and enrolled in EGET3171. Seven of the 57 withdrew from the course before its completion, leaving 50 students who received course grades. Sixty-seven of the students scored below 20 percent and were required to take MATH1120. All 124 students were used in calculating the validity of the CAL-T corrected for restriction of range.

Procedure

The CAL-T was administered as it had been for Study 1. In accordance with the prerequisites set for EGET3171, only the students who scored 20 percent or better on the CAL-T were allowed

to enroll in EGET3171. The letter grades for the 50 students who completed EGET3171 were recorded and used for the criterion. As in Study 1, A = 4, B = 3, C = 2, D = 1, F = 0.

Results

Using only the 50 students who completed EGET3171, the CAL-T correlated significantly ($r = .32$, $p < .05$) with EGET3171 grades, corroborating the validity of the quiz as a predictor of success in the course. The mean CAL-T score for this subsample was 40.20 (SD = 14.59); the mean grade for EGET3171 was 2.2 (SD = 1.29). The number of students earning the various grades in EGET3171 were as follows: A, 10 (20%); B, 10 (20%); C, 17 (34%); D, 6 (12%), F, 7 (14%).

The quiz's validity coefficient corrected for restriction of range was $r = .39$ ($p < .01$, $n = 124$). The mean CAL-T score with the unrestricted sample was 22.31 (SD = 19.54). The internal consistency of the quiz was estimated using the Kuder-Richardson Formula 20 and was $r_{KR} = .91$. Given that all students who enrolled in EGET3171 had also completed MATH4, the latter could not be used as a predictor in the regression analysis.

General Discussion

The results of these two studies demonstrate that a valid test can be very useful for placing students transferring from community colleges to a university. The two types of institutions

can develop and follow their respective missions while at the same time interface in such a way as to provide for a smooth transition for students transferring from the community colleges to the university. A valid test such as the CAL-T facilitates a smooth transition.

The benefits of such a quiz include the following. First, combining the efforts of the community colleges and UNCC helps to obviate the United States' predicted shortage of future engineers (A new agenda for science, 1987). In addition, developing and utilizing a placement test for the transfer students has helped maintain the working relationship between the community colleges and UNCC and has avoided unwanted competition between the two.

It is interesting that the CAL-T score accounted for more EGET3171 grade variance in Study 1 (r^2 = .29) than it did in Study 2 (r^2 = .15), using the correlation corrected for restriction of range. One possible explanation is the involvement of different instructors for Study 1 and Study 2. None of the instructors involved with Study 1 were involved with Study 2. The different sets of instructors may have had different grading procedures. A third validity study is currently being conducted to better understand how the difference in instructors may affect the validity of the quiz.

Notwithstanding the slightly lower validity coefficient for CAL-T for Study 2 ($r = .39$) compared with that for Study 1 ($r = .54$), CAL-T still seems to be a good predictor of success in EGET3171. As a result, more time consuming and complex alternatives do not appear to be necessary at this time to remedy the problems that once existed, i. e., the high failure rate in EGET3171 and the concomitant frustration of the students.

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Table 1

Descriptive Statistics for the Technology Math Placement Quiz (CAL-T), Completion of MATH4, and EGET3171 Grade for Study 1

Variable	Mean	Standard Deviation
CAL-T	28.22	17.71
Completion of MATH4[a]	0.67	0.48
EGET3171 Grade[b]	2.41	1.24

Note. n = 63.

[a]Completion of MATH4 was dummy coded, with 0 = "Did not complete MATH4" and 1 = "Did complete MATH4." [b]For EGET3171 Grade A = 4, B = 3, C = 2, D = 1, F = 0.

Table 2

Stepwise Regression Analysis Results for Study 1, with the Technology Math Placement Quiz (CAL-T) and Completion of MATH4 the Predictors and EGET3171 Grade the Criterion

Predictor	Coefficient	t	R
CAL-T	0.028612*	3.997	0.541
Completion of MATH4[a]	1.056651*	3.961	0.663
Constant	0.900983		

Note. n = 63. For EGET3171 Grade, A = 4, B = 3, C = 2, D = 1, F = 0.

[a]Completion of MATH4 was dummy coded, with 0 = "Did not complete MATH4" and 1 = "Did complete MATH4."

*$p < .001$